FURTHER OBSERVATIONS ON THE TRYPANOSOMES OF GAME AND DOMESTIC STOCK IN NORTH EASTERN RHODESIA

BY

ALLAN KINGHORN

AND

WARRINGTON YORKE

(Seventh Interim Report of the Luangwa Sleeping Sickness Commission, British South Africa Company)

(Received for publication 7 December, 1912)

In a former report* we described the various trypanosomes found in game and domestic animals in the vicinity of Nawalia in the Luangwa Valley. At the end of April the headquarters of the Commission were removed from Nawalia to Ngoa on the Congo-Zambesi watershed; and during our stay at the latter place the game and domestic animals were examined for trypanosomes in a similar manner.

In this communication we give the complete results obtained by examination of the big game, domestic stock and small vermin during our sojourn in Rhodesia.

The routine method of examination adopted by us was that described in our previous paper.

EXAMINATION OF GAME AT NAWALIA AND NGOA

A total of 127 head of game, comprising 19 genera, was examined at Nawalia, and trypanosomes were found by direct examination, by inoculation, or by both methods, in 33.

* Kinghorn and Yorke, Annals of Tropical Medicine and Parasitology, 1912, Vol. VI, No. 3A, p. 301.

At Ngoa, 124 wild animals, belonging to 16 genera, were examined, and trypanosomes were found in 21—a percentage of 16·9. Details are given in Tables 1 and 2.

TABLE 1.—Results of examination of game for trypanosomes at Nawalia.

Animal	Number examined	Number in which trypanosomes were found in buck's blood	Number inoculations made	Number positive inoculations in which parasites were seen in buck's blood	Number positive inoculations in which no parasites were seen in buck's blood	Total number buck found infected by examination and inoculation
1. Elephant	1	0	1	0	0	0
2. Rhinoceros	1	0	1	0	0	0
3. Hippopotamus ...	1	0	0	0	0	0
4. Zebra	5	0	3	0	0	0
5 Roan	8	1	2	0	0	1
6. Wildebeest	2	0	1	0	0	0
7. Kudu	7	3	3	1	1	4
8. Hartebeest	6	0	1	0	1	1
9. Waterbuck	28	16	14	5	1	17
10. Puku	10	1	6	0	0	1
11. Mpala	29	1	13	1	1	2
12. Bushbuck	9	4	6	1	2	6
13. Bushpig	4	0	1	0	0	0
14. Warthog	9	0	3	0	1	1
15. Lion	2	0	0	0	0	0
16. Hunting dog ...	1	0	1	0	0	0
17. Giant rat	1	0	0	0	0	0
18. Genet	2	0	0	0	0	0
19. Squirrel	1	0	0	0	0	0
	127	26	56	8	7	33

Table 2.—Results of examination of game for trypanosomes at Ngoa.

Animal	Number examined	Number in which trypanosomes were found in buck's blood	Number inoculations made	Number positive inoculations in which parasites were seen in buck's blood	Number positive inoculations in which no parasites were seen in buck's blood	Total number buck found infected by examination and inoculation
1. Rhinoceros	6	0	3	0	0	0
2. Zebra	17	0	5	0	0	0
3. Buffalo	6	0	3	0	0	0
4. Eland	15	0	12	0	4	4
5. Roan	5	0	3	0	1	1
6. Hartebeest	8	0	4	0	0	0
7. Waterbuck	27	12	15	3	0	12
8. Puku	8	1	6	0	0	1
9. Sitatunga	2	1	0	0	0	1
10. Duiker	9	2	4	0	0	2
11. Klipspringer	2	0	1	0	0	0
12. Warthog	12	0	3	0	0	0
13. Hyaena	2	0	1	0	0	0
14. Caracal	2	0	0	0	0	0
15. Galago	1	0	0	0	0	0
16. Reedbuck	2	0	0	0	0	0
	124	16	60	3	5	21

It will be seen that parasites were found at Nawalia by direct examination in 26 cases, a percentage of 20·4, while at Ngoa trypanosomes were found in the peripheral blood of only 16 buck—13·0 per cent. These are high figures for single observations, and it is probable that had several preparations from each buck been searched, the percentage of successes would have been much greater.

In several instances, only a single trypanosome was found in a film covering the greater part of a slide, and this after a very careful examination extending over two hours.

A more accurate estimate of the percentage of animals harbouring trypanosomes is afforded by considering only those from which inoculations were made. An analysis of these gives the following figures:—

	Nawalia	Ngoa
Number of inoculations made	56 ...	60
Number of positive inoculations in which parasites were found in buck's blood...	8 ...	3
Number of positive inoculations in which no parasites were found in buck's blood	7 ...	5
Number of negative inoculations in which parasites were found in buck's blood...	6 ...	6
Total number infected	21 ...	14

These figures show that at least 37·5 per cent. (Nawalia) and 23·3 per cent. (Ngoa) of the local fauna were infected with the trypanosomes of man or domestic stock. The percentage of big game found to be infected with the human parasite (*T. rhodesiense*) was, at Nawalia 16, and Ngoa 3·3. Both *T. vivax* and *T. nanum* have been found in game, and to both these species monkeys and rats are refractory, so that no conclusions can be drawn regarding the presence or absence of these trypanosomes in animals in which parasites were not found in the blood smears. Had sheep and goats been available for inoculation, it is probable that many more buck would have been shown to harbour the two organisms in question. As a conservative estimate, the percentage of game actually infected with trypanosomes (pathogenic to man or domestic stock) in the vicinity of Nawalia might be placed at 50, and at Ngoa 35.

A further point which is brought out in the tables is that different species of buck appear to vary widely in their susceptibility. Amongst the commoner varieties, trypanosomes were never found, either by direct examination or by inoculation, in zebra, buffalo, wildebeest and bushpig, and only rarely in roan, hartebeest, puku, mpala, and warthog. Waterbuck, eland, bushbuck, and kudu were the species found to be most heavily infected.

Table 3.—Percentages of various species of game found infected with trypanosomes at Nawalia.

Animal	Number examined	Percentage harbouring trypanosomes
Bushbuck	9	66·6
Waterbuck	28	60·7
Kudu	7	57·1
Hartebeest	6	16·6
Roan	8	18·5
Warthog	9	11·1
Puku	10	10·0
Mpala	29	6·9

Table 4.—Percentages of various species of game found infected with trypanosomes at Ngoa.

Animal	Number examined	Percentage harbouring trypanosomes
Sitatunga	2	50
Waterbuck	27	44·4
Eland	15	26·6
Duiker	9	22·2
Roan	5	20
Puku	8	12·5

To a certain extent, perhaps, these differences may be accounted for by the habitats affected by the various species of game. Kudu and bushbuck, and waterbuck to a lesser extent, are usually found in thick cover, from which they seldom emerge, and where they are more constantly exposed to the bites of tsetse flies. Mpala, puku and wildebeest are usually found in open country, frequently remaining for the greater part of the day on wide, bare plains, and here the flies are less noticeable than in the bush. Specific differences in the amount of immunity enjoyed by buck are probably, however, of much greater importance.

In Tables 5 and 6 are given the species of trypanosomes occurring in each animal in which parasites were found. In

Table 5.—Trypanosomes found in game at Nawalia

Animal	Trypanosomes found in peripheral blood	Trypanosomes isolated by inoculation into monkeys and rats	Diagnosis
Bushbuck ... 1 ...	Negative	*T. pecorum*	*T. pecorum*
,, ... 2 ...	*T. pecorum* or *T. nanum*	Negative	*T. nanum*
,, ... 3 ...	*T. multiforme*, sp. nov.	*T. multiforme*, sp. nov.	*T. multiforme*, sp. nov.
,, ... 4 ...	*T. pecorum* or *T. nanum*	no inoculation	*T. pecorum* or *T. nanum*
,, ... 5 ...	*T. pecorum* or *T. nenum*	,,	*T. pecorum* or *T. nanum*
,, ... 6 ...	Negative	*T. rhodesiense*	*T. rhodesiense*
Waterbuck ... 1 ...	*T. pecorum* or *T. nanum*	*T. pecorum*	*T. pecorum*
,, ... 2 ...	*T. pecorum* or *T. nanum*	*T. pecorum* and *T. rhodesiense*	*T. pecorum* and *T. rhodesiense*
,, ... 3 ...	*T. pecorum* or *T. nanum* and *T. vivax*	Negative	*T. nanum* and *T. vivax*
,, ... 4 ...	*T. pecorum* or *T. nanum*	,,	*T. nanum*
,, ... 5 ...	Negative	*T. pecorum*	*T. pecorum*
,, ... 6 ...	*T. vivax*	Negative	*T. vivax*
,, ... 7 ...	*T. vivax*	,,	*T. vivax*
,, ... 8 ...	*T. rhodesiense*	*T. rhodesiense*	*T. rhodesiense*
,, ... 9 ...	*T. pecorum* or *T. nanum* and *T. vivax*	Negative	*T. nanum* and *T. vivax*
,, ... 10 ...	*T. pecorum* or *T. nanum*	No inoculation	*T. pecorum* or *T. nanum*
,, ... 11 ...	(?) *T. rhodesiense*	Animal died day after inoculation	(?) *T. rhodesiense*
,, ... 12 ...	*T. rhodesiense*	*T. rhodesiense* and *T. pecorum*	*T. rhodesiense* and *T. pecorum*
,, ... 13 ...	*T. vivax*	No inoculation	*T. vivax*
,, ... 14 ...	*T. rhodesiense* and *T. vivax*	*T. rhodesiense*	*T. rhodesiense* and *T. vivax*

TABLE 5 *continued.*—Trypanosomes found in game at Nawalia

Animal	Trypanosomes found in peripheral blood	Trypanosomes isolated by inoculation into monkeys and rats	Diagnosis
Waterbuck ... 15 ...	*T. vivax*	No inoculation	*T. vivax*
,, ... 16 ...	(?) *T. rhodesiense* and *T. vivax*	,,	(?) *T. rhodesiense* and *T. vivax*
,, ... 17 ...	(?) *T. rhodesiense*	,,	(?) *T. rhodesiense*
Kudu ... 1 ...	Negative	*T. pecorum*	*T. pecorum*
,, ... 2 ...	*T. pecorum* or *T. nanum*	No inoculation	*T. pecorum* or *T. nanum*
,, ... 3 ...	*T. pecorum* or *T. nanum*	*T. pecorum*	*T. pecorum*
,, ... 4 ...	*T. pecorum* or *T. nanum*	No inoculation	*T. pecorum* or *T. nanum*
Roan ... 1 ...	*T. pecorum* or *T. nanum*	,,	*T. pecorum* or *T. nanum*
Warthog ... 1 ...	Negative	*T. rhodesiense*	*T. rhodesiense*
Puku ... 1 ...	*T. vivax*	No inoculation	*T. vivax*
Mpala ... 1 ...	Negative	*T. rhodesiense*	*T. rhodesiense*
,, ... 2 ...	*T. pecorum* or *T. nanum*	*T. pecorum* and *T. rhodesiense*	*T. pecorum* and *T. rhodesiense*
Hartebeest ... 1 ...	Negative	*T. rhodesiense*	*T. rhodesiense*

compiling the tables, information obtained from the result of inoculations, where these were made, has been utilised. This enables a differentiation to be made between such parasites as *T. pecorum* and *T. nanum*, which are morphologically indistinguishable. *T. vivax* has a characteristic morphology, and can thus be identified in blood smears without difficulty.

As would be expected, double infections are not uncommon amongst game, and several instances of this are recorded in the Tables.

No data exist as to the ultimate effect of infection on game. All the animals which were shot appeared to be in perfect condition, and presented no objective signs of disease. Whether or not buck succumb to trypanosomiasis it is impossible to say, but as they have

increased steadily since rinderpest swept through the country, it may be assumed that their tolerance to trypanosomes is very great.

Table 6.—Trypanosomes found in game at Ngoa.

Animal	Trypanosomes found in peripheral blood	Trypanosomes isolated by inoculations into monkeys and rats	Diagnosis
Waterbuck ... 1 ...	*T. vivax*	No inoculation	*T. vivax*
,, ... 2 ...	,,	,,	,,
,, ... 3 ...	,,	,,	,,
,, ... 4 ...	,,	Negative	,,
,, ... 5 ...	,,	,,	,,
,, ... 6 ...	,,	*T. rhodesiense*	*T. vivax* and *T. rhodesiense*
,, ... 7 ...	,,	,,	*T. vivax* and *T. rhodesiense*
,, ... 8 ...	,,	Negative	*T. vivax*
,, ... 9 ...	,,	*T. pecorum*	*T. vivax* and *T. pecorum*
,, ... 10 ...	,,	Negative	*T. vivax*
,, ... 11 ...	,,	No inoculation	,,
,, ... 12 ...	,,	,,	,,
Eland ... 1 ...	Negative	*T. pecorum*	*T. pecorum*
,, ... 2 ...	,,	,,	,,
,, ... 3 ...	,,	,,	,,
,, ... 4 ...	,,	,,	,,
Roan ... 1 ...	,,	,,	,,
Puku ... 1 ...	*T. vivax*	Negative	*T. vivax*
Sitatunga ... 1 ...	*T. ingens* (?)	No inoculation	*T. ingens* (?)
Duiker ... 1 ...	*T. vivax*	Negative	*T. vivax*
,, ... 2 ...	*T. pecorum* or *T. nanum*	No inoculation	*T. pecorum* or *T. nanum*

EXAMINATION OF DOMESTIC STOCK

The domestic animals examined, and the species of trypanosomes found in them, are given in Tables 7 and 8.

TABLE 7.—Examination of domestic stock for trypanosomes at Nawalia.

Animal	Trypanosomes found in peripheral blood	Trypanosomes isolated by inoculation into monkeys and rats	Diagnosis
Cow	*T. pecorum* or	No inoculation	*T. pecorum* or
	T. nanum		*T. nanum*
,, ...	*T. pecorum* or	,,	*T. pecorum* or
	T. nanum		*T. nanum*
Goat ... 39 ...	*T. vivax*	Negative	*T. vivax*
,, ... 94 ...	*T. vivax* and	,,	*T. vivax* and
	T. nanum or		*T. nanum*
	T. pecorum		
,, ...202 ...	*T. pecorum* or	,,	*T. nanum*
	T. nanum		
,, ...258 ...	*T. vivax*	,,	*T. vivax*
Dog	*T. rhodesiense*	*T. rhodesiense*	*T. rhodesiense*
,, ...	*T. pecorum*	*T. pecorum*	*T. pecorum*
,, ...	,,	No inoculation	,,
,, ...	,,	,,	,,
,, ...	*T.* sp. (*montgomeryi* ?)	Negative	*T.* sp. (*montgomeryi* ?)

TABLE 8.—Examination of domestic stock for trypanosomes at Ngoa.

Animal	Trypanosomes found in peripheral blood	Trypanosomes isolated by inoculation into monkeys and rats	Diagnosis
Goat ...369 ...	*T. nanum* or	No inoculation	*T. nanum* or
	T. pecorum		*T. pecorum*
,, ...375 ...	*T. vivax* and	,,	*T. vivax* and
	T. nanum or		*T. nanum* or
	T. pecorum		*T. pecorum*
,, ...378 ...	*T. vivax* and	*T. pecorum*	*T. vivax* and
	T. nanum or		*T. pecorum*
	T. pecorum		

The only native village in which cattle were found was Kambwiri's, some 40 miles south-west of Nawalia. At present there are only two head, all that are left of a big herd which existed there some four or five years ago. One of the two appeared to be in good condition when seen, but the other beast was obviously ill. The cow in which trypanosomes were found at Fort Jameson was bred on the Government Farm, and had never been beyond the limits of the township. Tsetse flies have never been seen within some miles of the place, but *Stomoxys* is abundant in the kraals, and at certain seasons of the year various species of *Tabanidae* are common.

In several of the villages on the main road from Nawalia to Fort Jameson a number of goats were found at the end of August, 1911, and again at the beginning of April, 1912, but at the end of that month not a single animal was alive. *Glossina morsitans* was found around all these villages. The four goats mentioned in Table 7 were under observation at Nawalia for a considerable length of time. During this period, parasites were found in the peripheral blood only at rare intervals. Two were rather thin, but not markedly so, and, apart from this, there were no signs of disease. Goat No. 258 was examined at frequent intervals for two months before parasites were first found, while in the others, trypanosomes were seen on the first occasion. Nos. 39 and 258, after having been under observation for nine and four months respectively, died on the road when the Commission left Nawalia, most probably from being over-driven. The other two are still alive, seven and four months after the diagnosis was made.

The dog in which *T. rhodesiense* was found came from a village just on the Nyasaland border. The natives said that it had been out of the village for over a year previously. As the disease runs an extremely acute course in these animals, there can be no doubt that the dog was infected locally.

EXAMINATION OF SMALL VERMIN

It has been suggested* that the small vermin might also act as reservoirs of trypanosomiasis. It must be remembered, however, that many of the small vermin of Tropical Africa are nocturnal, and are, therefore, not subjected to the bites of *Gl. morsitans*. At Nawalia and at Ngoa we examined in all 142 wild rats, 15 wild mice, 1 wild rabbit, 1 giant rat, 1 squirrel, 1 galago and 2 genet; the results were uniformly negative.

Not a single case of infection with trypanosomes was found in the 256 monkeys (*Cercopithecus pygerythus*) examined by us, although infection with filaria and plasmodium kochi was common.

The probable explanation of this is that the monkeys during the daytime catch the tsetse fly before the insects have time to feed on them, whereas, on the other hand, they are frequently bitten by mosquitos whilst they are asleep at night.

NGOA, NORTH RHODESIA,
August 31*st*, 1912.

* British Medical Journal, 1912, July 6. Report of Mr. Harcourt's speech in the House of Commons.